Japanese Patent Laid-Open No. 55-153393

SPECIFICATION

1. Title of the Invention

METHOD FOR MANUFACTURING CIRCUIT BOARD

2. Claims for the Patent

(1) A method for manufacturing a double-side metal foil overlaid circuit board, the method being characterized by coating a metal foil with varnish made of resin and an organic solvent in order to form an insulating layer on the metal foil, drying and hardening the varnish to pre-form what is called a cast laminate, and bonding the cast laminate to another cast laminate using an adhesive with the insulating layers located between the two cast laminates.

(2) The method for manufacturing a circuit board according to Claim 1, wherein the metal foil is selected from a copper foil, an aluminum foil, and an iron foil.

(3) The method for manufacturing a circuit board according to Claim 1 or 2, wherein the resin used to form the insulating layer consists mainly of a heat resistant resin selected from an epoxy-containing resin, a urethane-containing resin, a heat resistant resin having a heterocyclic ring, a phenol-containing resin, a silicon-containing resin, a polysulphone-containing resin, a polyester-containing resin, a polyamide-containing resin, and a combination thereof.

(4) The method for manufacturing a circuit board according to Claim 1 or 2, wherein the resin used to form the insulating layer consists mainly of a heat resistant resin of molecular weight at least 5,000 and having a heterocyclic ring, and an epoxy resin and/or a phenoxy

resin containing one or more hydroxide groups at least in a molecule, and the insulating layer has a thickness of at most 150 microns.

(5) The method for manufacturing a circuit board according to any of Claims 1 to 4, wherein the adhesive is a thermosetting silicon-containing resin.

3. Detailed Description of the Invention

The present invention relates to a method for manufacturing a double-side metal foil overlaid flexible circuit board which prevents an adhesive layer from being exposed from a surface of an insulating layer even after processing of the circuit by etching.

Description will be given of a common conventional method for manufacturing what is called a flexible double-side metal foil overlaid circuit board having a metal foil on the opposite sides of the circuit board.

First, an adhesive is coated on one surface of a metal foil and dried as required. The metal foil is then thermocompression-bonded to a film such as a polyester-containing resin or a polyimide-containing resin to form what is called a bonded laminate. Then, an adhesive is coated on a film side of the laminate film or on another metal foil, and the laminate film is similarly thermocompression-bonded to the metal foil. The circuit board obtained is composed of the metal foil, the adhesive, the insulating film, the adhesive, and the metal foil arranged in this order.

However, the circuit board configured as described above has the adhesive layer at the interface between the insulating layer and the metal foil. Thus, when unwanted parts of the metal foil are removed by etching processing or the like, the adhesive layer is exposed, posing the following problems.

The surface physical properties of the circuit board obtained depend on the properties of the adhesive. Thus, even if an expensive high-performance film such as a polyimide-containing film is used as an insulating film, the surface performance of the film is reduced or degraded. In other words, even though the circuit board has excellent functions, because the adhesive layer requires various advanced surface performances, many circuit boards are unavailable owing to disadvantages concerning surface physical properties. This limits the selection of the adhesive. Specifically, (1) when a thermosetting silicone resin adhesive, which has a high heat resistance, a high adhesiveness, and a high flexibility, is used for adhesion, the circuit board is unavailable because of the less adhesion between the resin and a solder resist or ink such as cover coat ink, used to process the circuit; the less adhesion is one of a few disadvantages of the thermosetting silicone resin. (2) The use of a rubber-containing adhesive, which is excellent in adhesion and flexibility, degrades the heat resistance as well as the adhesion between the circuit portion and the insulating film during a solder processing step. (3) The use of a nylon-containing adhesive, which is excellent in adhesiveness, degrades the moisture-resistant insulating capability of a circuit owing to the excellent water absorbing property of the adhesive. Consequently, adhesives averagely having all the capabilities have been unsatisfactorily used.

To solve these problems, examinations have been widely made on cast laminates not using any adhesive. A method has been proposed which involves dissolving, for example, a heat resistant resin having a heterocyclic ring in an organic solvent, coating the solvent on one surface of a metal foil, and drying and hardening the solvent

to obtain a circuit board. However, all these measures are directed for single-side metal overlaid circuit boards, and an attempt to apply the present scheme to double-side circuit boards may lead to inconveniences. One possible method is to cast a resin solution on a metal foil in order to form an insulating layer thereon, dry the resin solution to remove an organic solvent, harden the solution to a B stage as required, and bond another metal foil to the first metal foil by thermocompression. In this case, to achieve adhesiveness, it is essential that the thermocompression insulating adhesive layer be flowable. However, the flowability makes the thickness of the insulating layer nonuniform as a result of the thermocompression pressure. In an extreme case, pin holes may be formed, and the essence of the insulating layer is lost. This serious disadvantage prevents this method from being put to practical use. Further, such method is in principle possible with resins such as an epoxy resin which can have the B stage. However, a high-boiling-point solvent is used for heat resistant resins having a heterocyclic ring and commonly preferably used for flexible insulating circuit boards, such as a polyamideimide resin and a polyimide resin. The high-boiling-point solvent needs to be completely removed. However, if such a resin is used and the solvent is completely removed, the thermocompression adhesiveness is lost, precluding the subsequent lamination. Thus, the lamination based on such method may be often impossible depending on the type of the resin.

For this reason, the manufacture of a double-side metal overlaid circuit board of a cast laminate is considered to be impossible. Thus, at present, only the single-side metal foil overlaid circuit board is used. The single-side circuit has the above excellent properties

but also has the following disadvantages. The upper and lower surfaces composed of the metal foil and the insulating layer are asymmetric, resulting in the significant occurrence of what is called curling or the likelihood of wrinkles resulting from circuit processing by etching. The absence of an adhesive layer leads to the unavoidable formation of pin holes in connection with dielectric breakdown. On the other hand, the increased density of electronic parts has resulted in a continuous increase in the demand for double-side metal overlaid circuit boards. It is also true that the industry as a whole is requesting the development of excellent flexible double-side metal foil overlaid circuit boards.

On the basis of the clear understanding of the above situations, the inventors made various examinations on a method for solving all the problems with the conventional flexible circuit boards at a time. The inventors have thus reached the present invention taking the advantages of a cast laminate method and a bonding laminate method. This method involves simple lamination of two cast laminates but is significantly effective in that a structure obtained by the method can solve the conventional problems at a time. The effect is more significant with a combination of a particular resin and a particular adhesive. That is, a desired resin varnish is pre-coated on a metal foil, a solvent is completely removed, and the resin varnish is completely hardened as required to obtain what is called a cast laminate. Subsequently, the laminate film and another laminate film are re-laminated with an adhesive to obtain a double-side metal circuit board. Thus, the significance of the present invention is the discovery of the excellence of the simple method which is not found in the conventional concepts.

The present invention will be described below in detail.

The present invention can use any metal foil such as a copper foil, an aluminum foil or an iron foil which is commonly used for circuit boards. However, a copper foil is generally used. Further, the insulating layer can be formed by using any resin that can be formed into a film by casting, for example, an epoxy-containing resin, a urethane-containing resin, a phenol-containing resin, silicone-containing resin, a polysulphone-containing resin, a polyester-containing resin, polyamide-containing resin, or a polyimide-containing resin. However, a thermosetting resin or a heat resistant resin is preferably used in terms of electrical properties, heat resistance, and the like. In particular, when an organic solvent solution is used which consists mainly of a resin, such as polyimide, polyamideimide, or polyesterimide, having a molecular weight of at least 5,000 and a heterocyclic ring, and a phenoxy resin and/or an epoxy resin having a hydroxide group at least in a molecule, the solution can be appropriately bonded to the metal foil and offers a high heat resistance, excellent shrink properties, a high film forming capability, and a high mechanical strength. The blend ratio of the heat resistant resin to the epoxy or phenoxy resin is preferably 100 pts.wt to 0.1 to 40 pts.wt.

A general method for forming an insulating layer involves dissolving a resin such as a polyimide-containing resin or an epoxy-containing rein into a solvent or the like to prepare what is called varnish, casting the varnish on a metal foil using a foiler, a roll coater, a coating machine, or the like, heating and drying the metal foil to completely remove the solvent, and then hardening the metal foil as required. The thickness of the insulating layer

can be optionally adjusted but is generally often at most 150 microns with an economical aspect taken into account. Thus, what is called a cast laminate is obtained which has the insulating layer mounted on one side of the metal foil without using any adhesive.

Then, the cast laminate obtained is bonded to another cast laminate with the insulating resin layers placed between the cast laminates with an adhesive.

In this case, any adhesive is available which can bond insulating resin layers together. The adhesive is used for the inner surfaces and is not exposed from a surface even after etching. This eliminates the demanding performance conventionally required for the adhesive, including resistance to chemicals used to produce a circuit board, adhesion with ink, surface electric insulating property, short-time solder heat resistance, non-stickiness, water absorbing property, arc resistance, tracking resistance, and various drift properties. This sharply increases the range of selection of the adhesive. In addition, the two insulating layers are used, and the inner layer serves as a bonding and insulating layer. Thus, as a secondary advantage, the probability that pin holes are formed as viewed from a surface conductor is close to zero.

However, among the adhesives described above, the thermosetting silicon-containing resin, which is excellent in heat resistance, flexibility, and adhesion but has not been used owing to inappropriate ink contact and printability, exerts particularly excellent effects. A method for forming an adhesive layer is available as required which involves coating an adhesive on one or both of the insulating layers on a cast laminate, removing a solvent, and then performing bonding by thermocompression, or placing, as the innermost layer, a film

adhesive or what is called a prepreg comprising any of various base materials impregnated with an adhesive and then performing thermocompression. Thus, a double-side metal foil overlaid flexible circuit board is obtained which is very excellent as a flexible circuit board.

An example is shown below, but the present invention is not limited to this example.

Example

A foiler was used to cast a flexible heat resistant epoxy resin (an acetone solution of a novolak epoxy resin) on a surface of a treated copper foil of thickness 35 microns. The copper foil was heated and hardened in a circulating hot air dryer at 150°C for 10 minutes and further at 200°C for one hour. Thus, two cast laminates were produced on which the heat resistant resin layer of thickness 20 microns was coated. Then, the foiler was used to cast a thermosetting silicone adhesive (SE-1700 manufactured by TORAY INDUSTRIES, INC.) diluted into toluene on the surface of the cast laminate on which the insulating layer was coated. The solvent was then sublimated to produce a cast laminate with the silicone resin adhesive layer of thickness 7 microns coated thereon. The cast laminate with the adhesive and another cast laminate were stacked via the adhesive layer with the copper foil facing outward. Pressing was performed at a pressure of 50 kg/cm^2 and at 150°C for 20 minutes to obtain a double-side copper foil overlaid flexible circuit board. In the flexible circuit board, various resists and the coat resin exhibited excellent adhesion therebetween even after etching. Further, the adhesion in the circuit part does not substantially vary over time. Therefore, the circuit board was very excellent.

Patent applicant: Sumitomo Bakelite Co., Ltd.